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# Interdependence between the farm business and the farm household with implications on economic efficiency

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# **Interdependence Between the Farm Business and the Farm Household With Implications on Economic Efficiency**

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## SUMMARY

1. This study indicates that important limitations to attaining economic efficiency in using farm resources are connected with the complex of firm-household interdependence. Little capital is used during both the beginning and closing phases of the farm life cycle because of different types of uncertainty and values of farm families. Limited extension of credit by the loan firms is particularly important for beginning farmers. Capital use is limited during the close of the farmer's operating career, mainly because the family opposes being in debt.

2. The low productivity of capital in the beginning and closing phases of the farm cycle has different implications. Older farm people are accustomed to the farm occupation, and their choice in life is to remain on the farm and continue with less strenuous operations. In contrast, most young families are more interested in increasing their income. They are limited mainly by productive assets. Here, both the individual farm family and consumers can gain from greater efficiency brought about by changes in the quantity and proportions of resources.

3. The amount of capital used by an operator is limited quite largely by his own equity because of uncertainty and farmers' subjective discounts in using borrowed capital. The capital of a beginning operator is limited to his equity plus his credit limit (either his own limit or that of credit firms). Up through middle age, as the farmer accumulates more capital, he is willing to borrow greater absolute amounts. Beyond this point he places high values on liquidity and security and attempts to pay off mortgages and attain a 100 percent equity. The interdependence of the farm business and farm household (including preferences of families) creates a cycle where the quantity of capital employed parallels the cycle of the farm family.

4. This cycle has several implications in economic efficiency. First, capital productivity is not equated between farms. Beginning farmers in general have a high capital productivity, because they have little capital. Capital productivity declines as the operator grows older and more capital is added as the scale of crop and livestock enterprises increases.

5. Although the older farmer also uses smaller amounts of capital than the middle-aged farmer, capital productivity tends to be low because it is directed into less productive uses. Also, the physical abilities of the older operator decline with age. Since labor and capital are technical complements in many ways, capital productivity tends to decline with labor

productivity. Finally, many older operators who were never able to attain an efficient sized operation or who never recovered from the setbacks of depression or family illness find themselves in a position of being unable to acquire enough capital to farm effectively.

6. Inefficiency also arises from the manner capital and other resources are combined. Beginning farmers who are short on capital place a premium on investments in crop machinery, machine services, seeds and other crop services for cash grain farming. These types of resources give a high return on the capital and labor employed and a "quick turnover." By placing emphasis on cash grain farming, the capital-short beginning farmer insures against business failure and grows into livestock farming as capital accumulation takes place. Consequently, the investment in forage crops, forage-consuming livestock and conservation practices generally is less on beginning farms than on farms of established farmers who have been able to accumulate capital and secure their business position. With high costs for land and other farm resources, it is likely that exploitive and non-conservation farming systems will continue to be found particularly on beginning farms where capital is limited. The beginning operator attaches less value to conservation of resources for later generations than on a "quick turnover" through row crops to help secure his financial position over his own lifetime.

7. Uncertainty and interdependence of the firm and household throughout the family's life cycle may bring about inefficiency at either end of the family life cycle. First, the young operator with little capital sees an uncertainty of production and tends to adapt his resources in the manner outlined in the text proper. Second, the older operator recognizes income uncertainty and the uncertainty of life itself. With a limited span of life before him, the older operator is reluctant to make investments involving large risks even though they may appear profitable. An unsuccessful investment adventure lessens the opportunity for recovery in the case of the older operator; his life expectancy is too short to begin the process of a new accumulation of capital. He is more concerned with farm returns and comfortable living for the rest of his life than in long-term investments, conservation farming systems and other commitments in resources which give returns over several generations. Several older operators in the sample emphasized that their concern with farming was exactly this: Exploitive operations were being followed because the operator had little capital and his particular concern was in obtaining enough income to provide for his family from year to year.

8. The entire structure of capital assets differs in the various phases of the life cycle of the farm. Not only does the quantity of capital and its proportioning and productivity change markedly but so does the manner in which resources are held. Young farmers acquire resources particularly through the rental market and their equity in production assets is lowest. Farmers of medium age depend more on the credit market while older operators attempt to build up full equities and obtain resource services and income from owned resources only.

9. Attitudes toward use of capital differ a great deal between the consumption and production and indebtedness and retirement systems. Uncertainty causes restrictions on capital use in early stages and causes a premium to be placed on *fund* systems of retirement.

# Interdependence Between the Farm Business and the Farm Household With Implications on Economic Efficiency

BY EARL O. HEADY, W. B. BACK AND G. A. PETERSON

In no other industry is the interdependence between the consuming household and the business firm so strong as in agriculture. The farm is a complete economic unit by itself. The business and household units are intertwined in the farm with production and consumption taking place in one central spot. Hence limited resources are allocated between the two in accordance with the preferences of the family. The economic problems of a farm exactly parallel those of a national economy and include the three major areas of choice and decision: (1) the allocation of resources or income between current and future consumption, (2) the allocation of limited resources or income in current production and (3) the distribution of current consumption income between different individuals. In reality, the first decision is largely one of allocation in production over time. Problems of production and consumption allocation at the farm level have received little attention in the general body of economic principles. In general, the economic principles applicable to the business firm have been developed independently of the consumption unit, and the logic of the consuming unit has been developed independently of the business firm. A more realistic approach for agriculture is to consider production and consumption as interdependent units.

Research and education in Land Grant colleges have also been focused largely upon the production and consumption sides of the farm as independent units. Recommendations to farmers by the agricultural scientists particularly, have taken the business firm element of the farm to be dominant; educational programs have included standard recommendations to masses of farmers without recognition of individual values and preferences of the farm family in consumption. Similarly, the major efforts of research and education in farm management and agricultural economics have focused on the firm component of the farm; recommendations to farmers have been couched almost entirely in terms of profit maximization.

Production for money income is only an intermediate goal of farm families. Money income is a means to more ultimate ends or goals in consumption. While some farmers may attempt to increase income because they attach values to profit



*per se*, most farm families work toward profit in order to consume the products money will buy or to make investments which will provide security in the future. Firm-household interdependence is important in determining the organization of farm resources and the activities of the farm family which correspond to the greatest family satisfaction at a given point in time. Also, the interdependence of the farm business and household has an important bearing on the farmer's choice of crop and livestock enterprises, soil conservation measures, precautions in investments for production or other decisions which relate to time. The close tie between the farm business and the farm household causes blanket recommendations for farmers to be unrealistic. Recommendations on production and resources need to be conditioned in terms of the family's goals or objectives and the means used to attain these goals.

The major objective of this study was to determine how specific family goals or values in consumption influence the efficiency in production. These goals and values are those which change with time, i.e., the values governing family allocation in consumption over its life span. The change in the importance of money income from farming relative to non-monetary objectives has an important bearing upon the efficient use of farm resources. One unique feature of the farm business firm is that it has a life cycle closely paralleling the life cycle of the household and goes through phases in much the same manner as the farm family. While this same tie-in between the firm and the household exists in the small-scale businesses of the service or handicraft industries, it is absent in the major industries where the corporate form of business organization predominates. In agriculture the "death" of the farm household ordinarily means the end of the particular farm business. Accordingly, each new generation of households in agriculture must start almost anew in the establishment of a farm business. This is in contrast to the situation in industries based on the corporate form of business organization—death of the capital-contributing household does not likewise cause death of the firm.

In past studies on economic efficiency in farming, little attention has been devoted to the implications of the life cycle of the firm and firm-household interdependence upon farm family production decisions. This study is devoted to the effects of the life cycle and family values on farming efficiency. It is exploratory in nature. Additional investigations are needed to attain more complete knowledge of the effects of these interrelationships upon managerial decisions and resource efficiency in farming.

## BASIC FIRM-HOUSEHOLD INTERRELATIONSHIPS AND CHOICE IN FARMING

Interdependence in business and household choices arises from resource limitations. Managerial decisions and choices in production could be completely independent of those of consumption if resources were available to, or were used by, the farmers in unlimited amounts. The problem of choosing among alternatives in production and consumption occurs only when resources are limited. Capital for production or consumption uses is limited either by the size of loans they can obtain or by their hesitancy to borrow funds. Hence, a large part of the firm-household interdependence may be caused by a restricted use of credit due to uncertainty. In this section, we outline the fundamental manner in which the farm business and the farm household become interrelated in decisions. More general laws and principles have been developed or reviewed by Boulding,<sup>1</sup> Hurwicz,<sup>2</sup> Friedman,<sup>3</sup> Savage,<sup>3</sup> Arrow,<sup>4</sup> Scitovszky,<sup>5</sup> Heady<sup>6</sup> and others. The purpose of this section is to produce a minimum framework of principles for use in an analysis of the data which follows.

### PRODUCTION POSSIBILITIES IN MONETARY AND NON-MONETARY ITEMS

The interdependence of a business firm and a consuming household can be outlined with the elementary and simplified illustrations provided in figs. 1, 2 and 3. These relate only to one decision-making period, say a year, but the life cycle is composed of many such periods of time. The curve *mn* in fig. 1 represents the production possibilities for the farmer with limited resources. If the farmer were to use all of his capital, labor and land in producing money returns (with only enough time out for eating, sleeping and other processes necessary to prevent physical exertion), a maximum of *om* money income could be produced in a single time period. However, money income represents only one choice in the use of labor or other resources. The farmer can use these resources for many other purposes. For example, rather

<sup>1</sup> Boulding, K. E. *Reconstruction of Economics*. John Wiley and Sons, Inc., New York, 1951, Ch. 8 and 9.

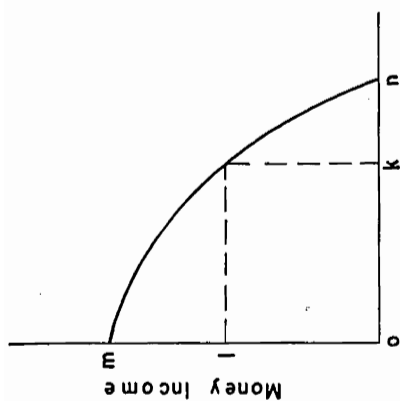
<sup>2</sup> Hurwicz, L. *A Theory of the Firm*. *Econometrica*, Vol. 14, pp. 109-135, 1946.

<sup>3</sup> Friedman, M. and Savage, L. J. *Utility Analysis of Choices Involving Risk*. *Jour. Pol. Econ.* Vol. 56, pp. 279-304, 1948.

<sup>4</sup> Arrow, K. J. *Social Choice and Individual Values*. Wiley, New York, 1951, Ch. 1, 2, and 3.

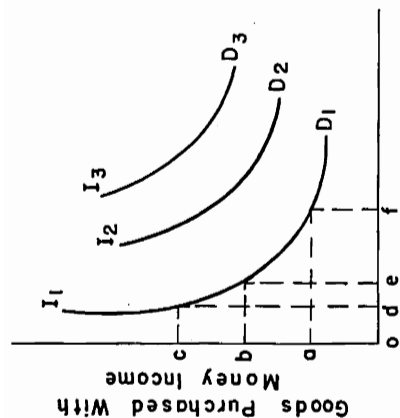
<sup>5</sup> Scitovszky, T. A. *Note on Profit Maximization and Its Implications*. *Rev. Econ. Studies*, Vol. 11, pp. 57-60, 1943.

<sup>6</sup> Heady, Earl O. *Economics of Agricultural Production*. Prentice-Hall, New York, Ch. 14 and 16, 1952.



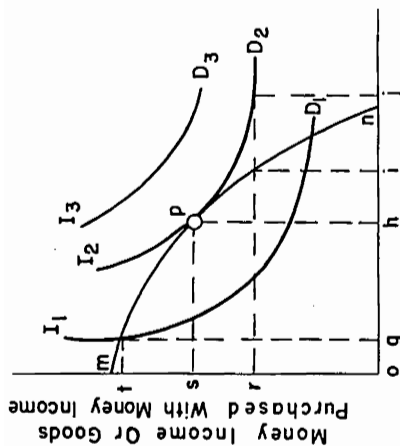
Goods Not Purchased With Money Income (Those Derived Directly From Resources Such As Leisure.)

Fig. 1



Leisure And Other Goods Derived Directly From Resources.

Fig. 2



Goods Not Purchased With Money Income.

Fig. 3

Fundamental relationships in firm-household interdependence.

than produce corn, wheat, hogs or other products which sell in the market and bring in cash corresponding to the money income  $om$ , he can accept a lower monetary income and devote some of these resources to leisure, fishing, vacationing or other non-monetary producing activities. Rather than devote all land operated to grain production and other cash producing crops, he can use some land for flowers or vegetables. He can use capital for livestock and machinery to produce money income or use some of this capital to obtain non-monetary objectives such as show animals, automobiles or electrical appliances. In the example, the farmer could produce  $on$  units of non-monetary items if he allocated all his capital, labor and land to these purposes.<sup>7</sup> Of course he can also produce combinations of monetary and non-monetary incomes consistent with the production opportunity curve  $mn$ . If he devotes one-half of his resources to each purpose, he can produce  $ol$  of money income and  $ok$  units of non-monetary income in a single time period.<sup>8</sup>

#### CONSUMER INDIFFERENCE CURVES

The curves of fig. 2 illustrate the nature of an individual's preference between monetary and non-monetary income at one point in time. A single curve indicates all of the possible combinations of the two categories which will give the individual the same level of satisfaction. All points on a single curve indicate the possible combinations of the two categories which will give the individual the same level of satisfaction. Since all points on a single curve, such as  $I_1D_1$ , indicate a single level of satisfaction, the slope of the curve in any region indicates the rate one category of products substitutes for the other in that region. In fig. 2 the individual's satisfaction or utility is at the same level for any of the three combinations: (1)  $oc$  of money income and  $od$  of non-monetary income, or (2)  $ob$  of money income and  $oe$  of non-monetary income or (3)  $oa$  of money income and  $of$  of non-monetary income. Curve  $I_1D_1$ , because it is convex to the origin (hollow from above), indicates an increasing amount of non-monetary income needed to compensate for the loss of each successive unit of money income. That is, more non-monetary income is needed to compensate for the loss of a unit of money income when the money income is

<sup>7</sup> Non-monetary is used here to describe individual activities which give satisfaction directly rather than indirectly through the medium of producing money income and the using of money to purchase satisfaction.

<sup>8</sup> The production opportunity curve  $mn$  in fig. 1 has been drawn concave to the origin indicating both products to be produced under conditions of diminishing returns. While linear and convex possibility or opportunity curves are also possible, these have not been illustrated because of space limitations.

low than when money income is high. If the original combination is *oc* of money income and *od* of non-monetary income, *de* units of the latter can be substituted for *cb* units of the former without causing the level of satisfaction to be changed. However, if another amount of money income equal to *ab* (or *cb*) is sacrificed, a larger amount of non-monetary income is now necessary to substitute for it—*ef* units of the latter are required to replace the *ab* units of the former.

Higher levels of satisfaction are represented by preference curves higher in the plane shown in fig. 2. Thus curve  $I_2D_2$  represents a higher level of satisfaction than curve  $I_1D_1$ , and  $I_3D_3$  in turn represents a higher level of satisfaction than curve  $I_2D_2$ . For any one curve, all points represent the same level of satisfaction. These preference curves describe a portion of the value system of one individual in respect to the alternatives specified. No two individuals have the same values, and the values for one individual will change over time.

#### BUSINESS CHOICES TO MAXIMIZE SATISFACTIONS

Figures 1 and 2 have illustrated the simple relationship in production opportunities and consumption preferences. These have important bearing on choices and decisions in the farm business and the farm household. Monetary income can be identified with the farm business and non-monetary income with the farm household. By combining the two sets of relationships of figs. 1 and 2 with one situation in fig. 3, the amount of each category of income desired by a farm family in a decision-making period can be illustrated. Curve *mn* in fig. 3 is identified with the production possibilities illustrated in fig. 1. Curves  $I_1D_1$ ,  $I_2D_2$  and  $I_3D_3$  are identical with the preference curves illustrated in fig. 2.

Only one possible use of capital, labor and management resources will allow maximum satisfaction for the individual farmer in a single time period. If satisfaction is to be at a maximum, he must strike the proper balance in use of his resources for the two income categories. This balance is represented by tangency of the production possibility curve *mn* and curve  $I_2D_2$ . Any other combination either gives less satisfaction or else satisfaction cannot be attained with the resources available. While any point on curve  $I_3D_3$  represents greater satisfaction than point *p* on curve  $I_2D_2$ ,  $I_3D_3$  lies entirely above *mn* and cannot be attained with the resources the farmer possesses. Of course, a combination such as *ol* of money income and *og* of non-monetary income can be produced. This combination lies on curve *mn*. However,

this combination is consistent only with curve  $I_1D_1$ . Since it is lower in the plane than  $I_2D_2$ , the farmer could always shift resources from the production of money income to using them for attaining non-monetary objectives and increase his satisfaction to the maximum indicated at point  $p$ . Again, however, he cannot shift the combination to include more non-monetary income than represented by  $oh$ , if satisfaction is to be at a maximum. While his level of satisfaction would remain the same as he shifted from point  $p$  to any other point on curve  $I_2D_2$ , this shift is not consistent with the production possibilities. On the side of consumption,  $hj$  units of non-monetary income are necessary to compensate for the  $rs$  units of money income. However, on the side of production only  $hi$  units of non-monetary income are possible when  $rs$  units of money income are sacrificed.

#### OTHER PRODUCTION-CONSUMPTION INTERRELATIONSHIPS

While the examples outlined above have compared monetary and non-monetary income, the same relationships apply to other choices in the firm-household complex. In fig. 3, for example, we could have indicated present income and consumption on the vertical axis and future income and consumption on the horizontal axis. The same examples could be used to illustrate what, in one production period, the individual allocates between present consumption and future consumption. An individual with a strong preference for future consumption relative to the present will accumulate productive assets at the expense of current consumption to make possible the greater future consumption. Allocation between present and future consumption changes with each change in the values of the individual. This has important implications on the amount of capital accumulated by the farm family in the form of productive assets and the pattern of this accumulation.

The principles outlined above illustrate relationships in both production and consumption to be considered when examining the way the individual uses the resources he possesses to maximize his satisfaction. The individual's allocation over time may be viewed as an attempt on his part to maximize his satisfaction for the particular time span he considers. It may be one individual is trying to maximize satisfaction during his lifetime. While we have employed a single period in the examples above, the principle outlined provides logic to explain why farmers may not attempt to maximize money profits in farming and how money income

motives may change over time. Most farmers could make more profit if they worked 16 hours per day for seven days of the week, purchased only food, clothing and shelter for subsistence and "plowed back" all their earnings into farm capital investment.

The degree to which business decisions and choices in the household are interrelated depends largely on the extent income or capital is limited. Choices in allocation are more limited for the low-income operator than for the wealthy farmer. Interdependence is more pronounced for the beginning farmer short on capital and who has a low equity than it is for the older, established operator. The degree of competition between firm and household for use of capital and income goes through a series of phases as the farm business is expanded. As capital accumulation in the form of productive assets takes place, non-monetary objectives may become relatively more important and eventually stop the accumulation. Additional family labor is furnished by the household as the family grows, and as changes in production opportunities occur. As members are added to the family and develop personalities and preferences, their influence on choices in consumption and production can be expected to change the manner in which resources are used. Thus, the slopes of the preference curves, such as those in fig. 2, change continually throughout the life cycle of the family. It is likely, however, that the values and preferences of the farm family are oriented toward one major goal in farm production—to attain the assets necessary to provide a standard of consumption consistent with the status desired in the community and the assurance of the maintenance of this standard. Thus, farm families desire security, both in old age and during the accumulation stages leading up to retirement. This goal may cause farmers to adopt various precautionary measures in production to insure against business failure. Paying off debts and the attainment of full equity in the assets of the farm are major elements entering into this goal of farm families.

#### EFFICIENCY IN FARM PRODUCTION

This study is devoted to the manner in which preferences of the family over the life cycle influence the efficiency and productivity of resources used on Central Iowa farms. If the resources possessed by a group of farmers do not meet the following tests, maximum efficiency has not been attained: (a) a maximum output must be forthcoming from given resources, or (b) a minimum of resources must be used for a given output. While choices made by each individual farmer

may be most efficient at a given stage in his life cycle when he considers production from within his own firm-household combine and apart from other farmers, they may not be most efficient when the possibilities of consolidation and co-operative action are present. For example, a father and son may operate independent units, one with a large amount of capital and one with a small amount. If through a father-son business arrangement the two can pool their labor and capital resources to produce a greater output and have a higher level of consumption, maximum efficiency is not attained when the two operate independent units. Some rough measurements are made of resource productivity and are used in a later section to determine whether possibilities do exist for rearranging farm production units to permit greater output from resources employed in a particular farming area. Analysis also is made of the values and attitudes farm operators attach to various levels and forms of capital accumulation and investment throughout the life cycle.

## SAMPLE AND PROCEDURE

This study has been centered on the role of family values in farm production within the time span of the life cycle of the farm business and the farm household. The design of the sample and the selection of empirical procedures were built around basic hypotheses on the nature of the change in the structure of productive assets over the farm family life cycle.

### THE SAMPLE

Two types of samples could be employed for an investigation of this type. First a time-series sample could be employed as a basis for predicting the effects of the family or household cycle on the use of resources in the farm business. A time-series sample designed for this purpose would include the same farmers or farm families for the entire period of the cycle. Records would be obtained from the farmer the year he begins farming and would be kept up to the time the farm household or the farm business ceases to exist. A sample of this nature might include 20 to 40 farms with a total operating span of 30 to 40 years. The continuous records over this period would provide information on farm production and family consumption during a family cycle. However, a sample of this nature, while desirable from many standpoints, is hardly feasible in terms of the costs involved and the life expectancy of an individual research worker. Time-series information, useful for purposes such as those outlined here, can be available in the future only as a by-



product of farm record associations or other activities where information is obtained on the same farms over a long period of time. But such records as currently exist do not contain the information desired nor do they cover the time period needed.

A cross-sectional sample was used instead of time-series data. Observations were drawn to include farms in all stages of the family cycle, from the beginning operator to the aged couple in semi-retirement. The data were used as a basis for predicting relationships and quantities expected in the continuous life cycle of individual farms. Productivity and use of resources, farmer attitudes toward capital accumulation and other attributes of concern in the study were obtained from farm operators of different ages. Then, these quantities were used to estimate the relationships existing for single operators through a life cycle.

The cross-sectional type of study may bring about certain inaccuracies in predictions for the future due to changes in the economic environment over time. Also, the attitudes of farmers of different ages or the capital they employ may differ because some have experienced only prosperous economic environments while others have had to recover from financial set-backs brought about by depression. Limitations of this nature should be kept in mind as the reader examines the empirical analysis of later sections. Time-series data, if available, also would be subject to similar limitations.

It also should be emphasized that cross-sectional observations do not account for farmers who stop farming. A time-series study could, of course, follow these operators from the time they begin operations and could provide explanations on why they stop farming. Finally, it should be reemphasized that this study was intended to serve as an inference only for single-firm (single manager) farms. Certain of the inefficiencies outlined do not come about under father-son, livestock-share leases or other types of business partnerships. (These arrangements do not, however, guarantee efficiency in beginning and closing stages of the farm life cycle.)

#### AREA AND METHOD OF SAMPLE

The cross-sectional sample was selected in the North Central Cash Grain Area of Iowa. This area of the state was selected to increase the homogeneity of the physical resources employed by farmers. Although variations do exist in the topography and productivity of Clarion and Webster soils, the area is more homogeneous in these respects than other sections of the state. From the 20 counties in this part



of the state, six counties were selected at random, three including 12 townships and three including 16 townships. A sample of counties rather than the universe of counties was selected in order to facilitate the compilation of the individual sampling units. Two townships from each of the 12 township counties and three townships from each of the 16 township counties then were selected at random. The sample list of farms was then built up for each of these sample townships.

The central concern of the investigation was to obtain information on the relationships in resource use and productivity during the family cycle. Regression was the appropriate statistical technique for measuring these relationships. In order to obtain a sample efficient for regression analysis, it was decided to select a sample stratified on the basis of the age of the operator. By selecting an equal number of farms falling at specific operator ages, it was possible to obtain as many farms falling at the extremes of the life distribution as in the middle.

Stratification by operator age was selected because previous information was not available on the life stage of the family alone. Other studies have shown operator age to be highly correlated with the family life cycle.<sup>9</sup> The sample was stratified on the basis of operator age and the empirical analysis employed operator age as the independent variable and basis for classifying farms. After a complete list of operators and ages was compiled for each sample township, two farmers were selected from each of the five age groups: (a) 30 years and under, (b) 31-40 years, (c) 41-50 years, (d) 51-60 years and (e) over 60 years. This system provided a sample of farmers not over-weighted in particular age intervals. The expected number of sample farms was 150 with 30 operators falling in each age group. The ages of operators were obtained from county assessors' field sheets. Substitute townships were used when ages were not available for townships already drawn randomly. Substitute townships were also selected on a random basis. In case of refusals, the following rule was followed for individual farms: Another operator was drawn randomly from the same age category and the same township. A total of 144 usable schedules were obtained in the survey conducted in the summer of 1950 for the previous business year.

<sup>9</sup> Cf. Cole, A. H., *Entrepreneurship As An Area of Research*. Jour. Econ. History Supplement, 1942, pp. 118-126.  
Loomis, C. P., *The Growth of the Farm Family in Relation to Its Activities*. North Car. Agr. Exp. Sta. Bul. 298, 1934.  
Loomis, C. P. and Hamilton, C. H., *Family Life Cycle Analysis*. Social Forces, Vol. 15, 225-231. 1951.

Table 1 shows certain of the family characteristics for the different age groups. For purposes of comparison, the older age group has been broken into two sub-groups. The more important part of the analysis is in the form of regression estimates rather than of group means. Age Group I of operators under 30 years included very few children of working age; the children drew from the household as consumers but contributed no production. Age Group II included as many "consumer" children as those contributing to production while Group III was mainly boys, and in many cases girls, who contributed to the labor resources of the farm business. Age Group IV, representing operators 60 years or older, was mostly children old enough to contribute to productive activities with few falling in the category of pure consumers. The majority of families in the older age included children who had left home and were providing their own support.

TABLE 1. FAMILY CHARACTERISTICS OF SAMPLE FARM FAMILIES

Item	Age group			
	I	II	III	IV
Number of operators	40	39	34	31
Average no. children per family	2	3	4	4
Percent of families with children at home				
below 5 years	80	46	12	0
6-16 years	23	72	41	12
17-21 years	0	23	50	22
over 21 years	0	5	12	26
Percent of families with children who have left household	0	23	68	81

## ANALYTICAL PROCEDURES

The attributes of the farms and farm families not adaptable to regression analysis were classified for a comparison of group means. The information obtained was adaptable largely for regression analysis. Most of the regressions included only 90 farms. This restricted sample was employed to reduce the errors of estimation. Regressions were, however, run for the original sample and are recorded in another report.<sup>10</sup> In all cases, the regression coefficients significant for the 90-farm sample also were significant for the 144 sample.

The regression analysis was restricted to 90 farms for these reasons: Original plans were to include only single-manager farms in the sample. During the sampling and survey process, farms including father-son agreements and characterized as two-generation or two-manager farms were excluded while other farms were substituted on a random

<sup>10</sup> Peterson, G. A., Firm-household interrelations in agriculture. Unpublished M. S. thesis. Iowa State College Library, Ames, Iowa. 1951.

selection basis. Because of misunderstanding of enumerators, questionnaires were taken for some of these cases. Accordingly, they were left out of the analysis. Originally the sample was selected in the Cash Grain Area to increase the homogeneity of resources employed by farmers and of farm organizations, except as affected by the farm life cycle. Other forces also cause the producing environment to differ between farms. One such consideration is market price. Some operators in the area are near towns and cities with favorable milk markets. Since the price-environment is not available to all farmers in the area, original plans called for excluding all farms except those organized on the typical basis of cash crops, hogs, beef and supplementary poultry and butterfat enterprises. Since these characteristics were not known before the enumeration, the farms were classified after the enumeration and dairy or other specialty farms were excluded from the analysis. Finally, the financial schedules were not complete enough on some farms for analysis of resource, combination and productivity.

## ANALYSIS OF DATA

Observations were obtained on the quantities and proportions of resources employed by farm businesses at different stages in the life cycle. In addition, data were obtained for measuring the productivity of resources and for examining farmer attitude toward the use of capital. In relating the farm cycle to various other phenomena, a simple second degree polynomial has been fitted to observations where a relationship conforming to the "rise" and "decline" of the farm family was expected.

## QUANTITIES OF RESOURCES USED

Economic efficiency as defined earlier is attained only when resources of the farm are combined in proportions and quantities consistent with (1) the minimum outlay for a given output or (2) the attainment of the maximum output from given resources. When management is comparable and if farming efficiency varies with the quantity of resources employed, great disparities in the quantities of resources employed per farm must lead to economic inefficiencies in agriculture.

## CHANGES IN THE AMOUNT OF LAND MANAGED

Land is the most important capital asset employed by farmers in North Central Iowa. The value of land managed by the farmers in the sample was 70 to 90 percent of the

total farm capital employed. Important changes in the number of acres and value of land operated take place over the life cycle. Changes in the quantity of land operated came about mainly through rental arrangements, although purchases and sales of land were important means of changing the amount of land managed.

*Acres operated.* The rise and decline in number of acres operated as age of operator increases is illustrated clearly in fig. 5. Farmers near the middle of the family cycle managed more land than farmers in the early and latter stages of the family. The number of acres operated, as an average, was 120 at operator age 25 and increased to a maximum of 196 acres at an operator age of 48. It then declined to about 120 acres at an operator age 70.<sup>11</sup>

The most important reasons for this rise and decline of acreage operated were: (1) the quantity of other assets available for combining with land, (2) the acreage available for renting and (3) the preferences of the farm families. Beginning farmers, in general, are short on capital and either

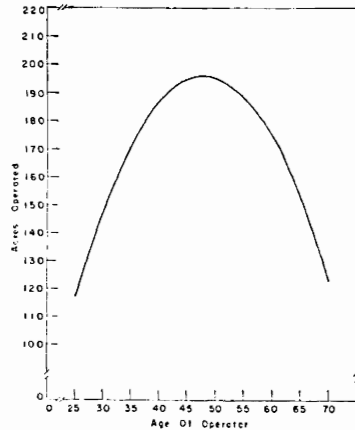


Fig. 5. Relationship of number of acres operated and age of operator.

are unwilling or unable to borrow capital to obtain the assets for combining with land. Thus, the amount of land operated is limited by the amount of machinery and operating capital available to the individual for use in farm production. Greater acreages are operated as accumulation of operating capital takes place and as a credit base is established permitting the farmer to borrow greater quantities of capital for operating expenses or other items used in production. As numerous operators indicated, farm rental customs restrict the size of the operating unit to the amount of machinery and other assets owned by the tenant. The increase in acres operated came about mainly through renting. However, pur-

<sup>11</sup> The regression equation for the curve in fig. 5 was  $Y_1 = 1441.87X - 15.05X^2 - 14893.63$ , where  $Y_1$  represented acres operated and  $X$  the age of the operator. The coefficients for the  $X$  and  $X^2$  terms in the equation were both significant at the 1 percent level. Ninety-five percent confidence limits on the coefficients were 490.68 to 2393.04 for the  $X$  term and -25.09 to -5.01 for the  $X^2$  term. These confidence limits have to be interpreted with care; the assessors' reports used in selecting the farmers for the sample were incomplete for some townships, necessitating some judgment in the sampling procedures. The confidence limits are presented mainly to provide the critical reader with some indication of the variability of the data.

chasing of land representing increases in acres operated was an important method of expanding the amount of land operated.

*Value of land operated.* Some persons believe that the value of land operated does not follow a cycle paralleling the quantity of land operated. This belief is based on the notion that beginning operators tend to locate on the poorer soils and a gradual "upgrading" takes place as shifts in farms are made. This hypothesis has been tested by the data in fig. 6. These data were based upon farmers' estimates of the market price of the land which they operated. Size of farm had no significant effect upon estimates per acre values.

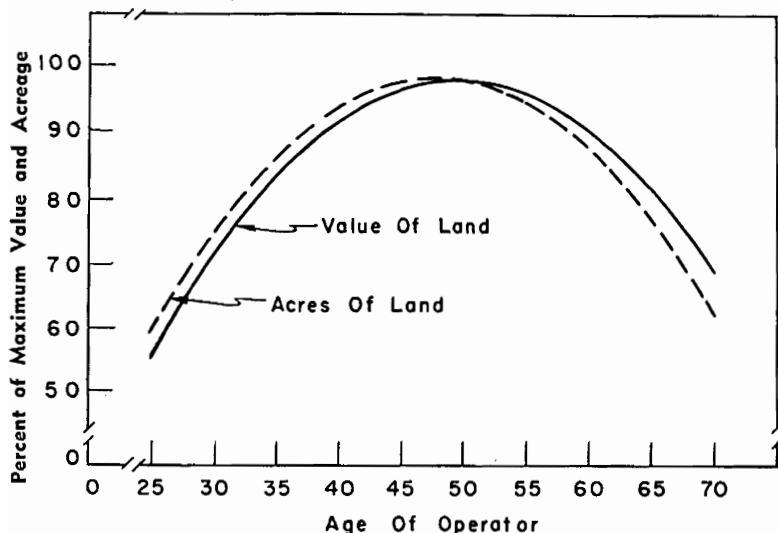


Fig. 6. Comparison of farmer estimates of land operated and acres operated in percent of maximum of each age of operator.

To relate the two measures of the land input to the life cycle of the farm, regression equations again were employed in both acre and value measures. These equations were changed to expressions in percentages. The average maximum acreage operated equals 100 and acreages below the maximum are expressed as a percentage of this quantity. Similarly, the value-of-land-operated regression equation was changed to percentages. As the curves of fig. 6 show, the cycles in the acreage operated and in the value of land operated were nearly parallel. Both the amount and value of land operated rise and decline with the increase in operator age, beginning with an average of 55-60 percent of maximum for an operator age 25 and ending with 55-65 percent of maximum at operator age 70.

## MACHINERY, LIVESTOCK AND TOTAL CAPITAL ASSETS

Capital investment in livestock and machinery followed a cyclical pattern similar to the increase and decrease in value and acres operated.<sup>12</sup> The regression line indicates an average value of livestock of \$2,500 at operator age 25. This increases to a maximum near operator age 48 and then declines to about \$4,500 at operator age 70 (see fig. 7). The average value of machinery per farm increased from about \$2,600 at operator age 25 to a maximum of \$7,300 at operator age 47 then declined to about \$2,300 at age 70. One would expect the investment in livestock to be more flexible for a farmer than the investment in machines since a minimum investment in machinery is required for farming whereas farming can be carried on without a livestock investment. This expectation was supported by the data. As capital accumulation occurred, farmers tended to increase livestock investment at a greater rate than machinery investment, although this difference was not large. Capital accumulation makes possible a change

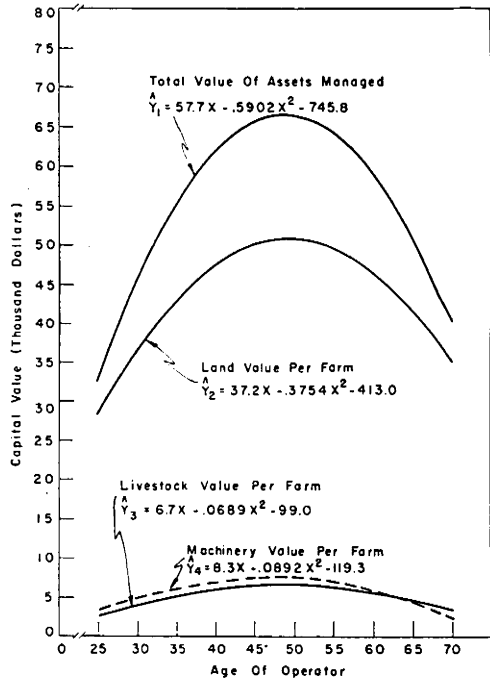


Fig. 7. Value of livestock, machinery and land, and total capital per farm by age of operator.

<sup>12</sup> The regression equations, for the categories of capital and total capital managed were:

$$Y_2 = 3718.62X - 37.544X^2 - 41302.96$$

$$Y_3 = 670.91X - 6.89X^2 - 9838.4$$

$$Y_4 = 830.04X - 8.92X^2 - 11934.84$$

$$Y_5 = 5770.94X - 59.02X^2 - 74575.75$$

Where  $Y_2$  = value of land managed,  $Y_3$  = value of livestock,  $Y_4$  = value of machinery,  $Y_5$  = total value of assets managed, and  $X$  = age of operator. The  $X$  and  $X^2$  coefficients in the above equations all were significant at the 1 percent level. Ninety-five percent confidence limits, to be interpreted as explained in other footnotes were:

$$Y_2 = 1167.50 \text{ to } 6269.74X; -64.48 \text{ to } -10.61X^2$$

$$Y_3 = 177.07 \text{ to } 1164.75X; -12.10 \text{ to } -1.67X^2$$

$$Y_4 = 441.75 \text{ to } 1218.33X; -13.02 \text{ to } -4.82X^2$$

$$Y_5 = 2522.47 \text{ to } 9019.42X; -93.31 \text{ to } -24.72X^2$$



in enterprise combinations to include more emphasis on livestock relative to cash grain farming. The beginning farmer, being short on capital, can operate with a smaller investment in livestock than machinery. The investment in machinery is determined mainly by the amount of land operated. The machinery investment decline in the latter half of the family cycle probably also occurs because of depreciation and because farmers do not purchase new machines when approaching the retirement period.

The total capital managed shown in fig. 7 was the sum of the individual categories of capital. Land capital was a greater proportion of this total than machinery and livestock capital combined.

#### FARM CYCLE AND EFFICIENCY IN PRODUCTION

What effect does the life cycle of the farm business and the farm household have on farming efficiency? Does the efficiency in resource use follow a cycle paralleling the cycles on the quantity of resources employed? In order to answer these important questions in the study, analysis has been made of the degree of efficiency found on sample farms at various stages of the life cycle. Efficiency is denoted in this case by the value of product produced per unit of resource employed. Interest here is in economic efficiency in the use of resources rather than in purely physical concepts of efficiency denoted by a maximum yield or output per unit of resource. Value productivity comparisons have limitations, of course, since they do not take into account the non-monetary values farm families attach to production. The advantage of the value productivity measure is that both the values consumers attach to different farm products and the farm family's interests in money returns are taken into account. Value productivity can serve as a criterion of efficiency under competitive conditions since the preferences of consumers are expressed in the prices of products. (The pricing system does not allow perfection in this respect because the necessary conditions in competitiveness are not fulfilled.) From the standpoint of the individual farm family, maximum economic efficiency is attained only when a maximum value product is produced from a given collection of resources. In other words, if an individual farmer can reorganize a given quantity of resources such as labor, land, machinery, livestock, fertilizer and other supplies to produce a greater physical product, he can always (a) increase his money profits and (b) increase the satisfactions of consumers by producing goods in the quantities and proportions they desire. Similarly, differences between farms in value returns

indicate the resources employed could be rearranged to allow a greater economic product. For these reasons, the value of product per unit of labor and capital resources employed is used below as an index of efficiency. Land is included as a capital resource along with all other forms of capital.

#### MEASURES OF EFFICIENCY

The marginal (additional) value product instead of the average value product is the ideal unit of comparison for gauging economic efficiency. Marginal value products are difficult to estimate with the desired precision, however. The measures employed in this study reflect the average productivity of resources for farms at different points in the life cycle. Marginal rather than average returns from resources should be used when great precision is needed in determining how resources should be rearranged. Average returns can be used as a basis for suggesting magnitudes of marginal returns when the production function is linear or when the average returns curve is linear.<sup>13</sup>

#### LABOR PRODUCTIVITY

Estimated average returns or average value product per man year of labor is shown in fig. 8. Labor returns were computed as a residual after the value product or returns to other resources were estimated by use of market prices. Labor productivity declined throughout the range of ages studied.<sup>14</sup>

These results indicate a higher average productivity of labor employed in the early stages of the life cycle than in the later stages. Several hypotheses thus exist for further study: A low productivity of labor in early stages of the cycle can be expected on farms because of a limited use of capital relative to labor. Evidently other forces offset this effect of capital and labor combinations. The addition of family labor as well as the decrease in the amount of actual work accomplished as age increases may contribute to the lower labor productivity in the later stages of the cycle. However, older operators prefer to work fewer hours and choose to produce products with a lower return per unit of labor. Higher returns to labor in the early stages of the life cycle also may be due to more intensive use of labor by beginning

<sup>13</sup> For further discussion on this point, see Heady, Earl O., *Economics of agricultural production and resource use*. Ch. 24. New York, Prentice-Hall, 1952.

<sup>14</sup> The average labor product curve is linear and hence a marginal returns curve would be linear with a slope twice as great as that of the average curve. In a test of significance, the value of *F* for departure from linear regression was .8691, an insignificant value.

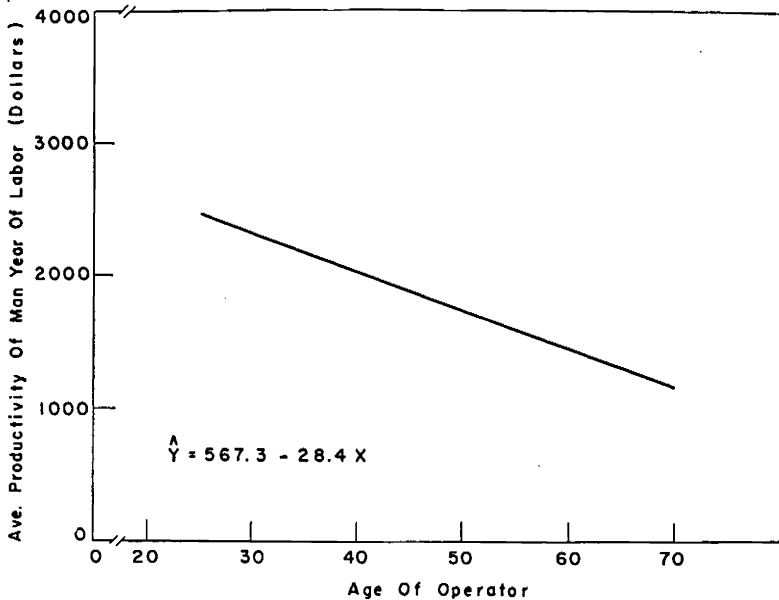


Fig. 8. Relationship between average productivity of a man year of labor and age of operator.

operators. On smaller farms, for example, labor may be used more in producing supplementary enterprises during off-seasons of the year than occurs on the larger farms. The majority of young operators also are perhaps physically capable of more strenuous work and longer working hours.

The relationship between months of man labor used and age of operator is shown in fig. 9. The amount of labor employed also goes through a cycle.<sup>15</sup> The growth and decline in the labor force is not as marked as for land and capital, however. Therefore, older operators tend to use a larger amount of labor relative to capital than those in the middle of the cycle. This change in the ratio of labor and capital contributes to the decline in labor productivity in later stages of the farm cycle. Several factors explain this increase and decrease in the use of labor. An increased amount of labor is used in early stages of the cycle as capital is accumulated and as family members are able to contribute to the working force.<sup>16</sup> The eventual decline in the number of months of man labor used occurs as family members leave home and as the operator curtails operations and releases hired help from the household.

<sup>15</sup> The F value in the test of significance of departure from linear regression was 152. This was significant at the 1 percent level.

<sup>16</sup> This is consistent with the conclusions from a study made by Loomis. His findings indicated that the size of the enterprise measured by acres in the farm was conditioned by the size of the working force.

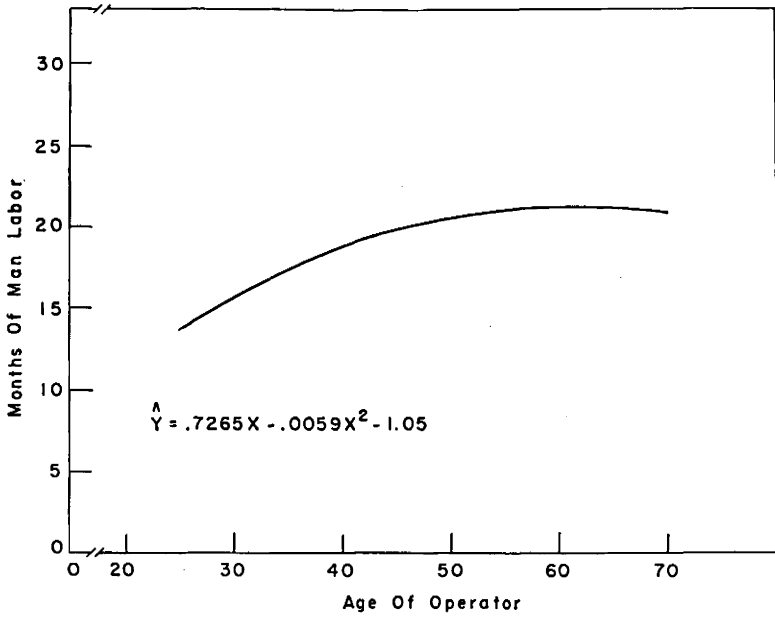


Fig. 9. Relationship between months of man labor and age of operator.

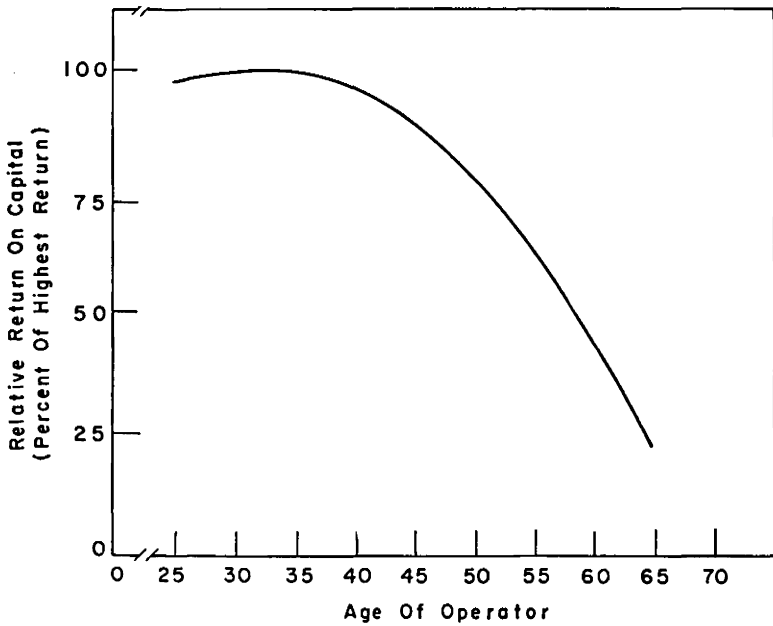


Fig. 10. Regression of relative capital return on operator age.

Average capital productivity also was computed as a residual. The residual product to capital was computed by imputing a return to labor equal to market wage rates. Land, buildings, livestock and all other resources used in production were converted to a dollar basis and the residual return was expressed as a percent return on this total amount of capital. In order to picture better the relative position of farms at different points in the life cycle, returns in fig. 10 are expressed relative to the highest returns earned at any point in the cycle.<sup>17</sup> The relative positions of farms at different points of the age cycle are shown below. Relative capital productivity begins at a level of about 90 for farmers at 25 years of age and rises to a maximum at an age around 35. It then declines throughout the remainder of the age range. Average capital at 60 years is less than 50 percent of the maximum attained at the younger age.<sup>18</sup>

Increasing productivity of capital in early stages of the cycle can be explained by the quantity of capital used in relation to other resources. Most beginning operators possess a small amount of capital relative to the quantity of labor available. As farming operations continue, the beginning operator is able to accumulate funds and acquire additional capital in the form of livestock, fertilizer and such. He is able to operate more land as funds become available for greater quantities of seed, fertilizer and tractor fuel. When capital is very limited, it serves as a technical complement to labor; use of more labor without capital to accompany it may add little or nothing to production and returns. Since the beginning operator has his own labor available over a 12-month period, the addition of capital allows a more

<sup>17</sup> The data of fig. 12 are based on an original regression equation  $Y = 2.39 + .32X - .0047X^2$  where Y refers to the percent return on capital and X refers to operator age. The F value for departure from linear regression was 93.5, a value significant at the 1 percent level of probability. After the curve of return on capital was computed, the highest return at any stage of the cycle was taken as 100 and returns at other stages of the cycle were expressed as a percent of this amount.

<sup>18</sup> Since both are residuals, it may appear that the labor and capital productivity curves should take the same form. The labor curve is linear while the capital curve is curvilinear, because of the nature of the labor force employed throughout the cycle and because of the method of computation followed. In computing the residual return to capital, the wage-value of labor was subtracted from the total value of production on each farm. Hence labor of older operators was given the same value as that of younger operators. Since it is likely true that younger operators work longer hours and perform more strenuous tasks, a month of labor input is greater on farms in early stages of the cycle than those in later stages. The valuation procedure which places equal values on labor at different points in the cycle thus may leave a smaller residual for capital and cause a "downward curvature" of the relative productivity curve in the late stage of the cycle. This phenomenon is itself of interest in this study, however, since concern is with the manner in which resource productivity changes at different stages of the cycle.

effective utilization of the operator's labor and hence may result in a type of "increasing return to capital." As the operator accumulates funds and extends the use of labor and capital, the quantity of these resources employed becomes sufficiently great that their average (and marginal) productivity declines. An important comparison can be made between the data of figs. 7 and 10 which show the cycles of capital productivity and the quantity of capital employed respectively. The productivity cycle reaches its maximum at an operator age of 33 while the quantity of capital reaches its maximum at an age of approximately 50. Thus, the return per unit of capital increases as operators add capital up to the quantity found at the 33-year age point; increasing returns to capital likely prevails as capital is added through this beginning range.

The rapid decline of average capital productivity during the later stages of the cycle can be explained by (1) the larger amounts of capital employed and (2) the employment of capital in areas of low productivity from a monetary standpoint. The latter is brought about partly by the increase in proportion of resources devoted to the attainment of non-monetary objectives as the age of the operator increases. The attainment of equity in the business assets facilitates this shift in resource employment.

#### RELATIONSHIP OF CROPS AND LIVESTOCK TO OPERATOR AGE

In addition to the quantity of assets employed, resource productivity is affected by the combination of farm enterprises. Farmers can attain maximum profits and consumers can attain farm products in the proportion desired if enterprises are combined in accordance with the ratio of the product prices and the ratio of the physical output possibilities. With a given price ratio, the exact point of an equilibrium for satisfying these conditions is determined by the nature of the production possibilities.<sup>10</sup> The combination of enterprises should be parallel on all farms with the same production possibilities and price ratio if profits are to be maximized and resources are to be used most efficiently from the consumer's standpoint. Figures 11 and 12 illustrate the way enterprises are combined as farms progress over the life cycle. Both indicate a rise and decline in total value

<sup>10</sup> These equilibrium conditions in case of two products may be stated formally as:  $\frac{\Delta B}{\Delta A} = \frac{P_a}{P_b}$ , where  $\Delta B/\Delta A$  is the marginal rate at which product A substitutes (replaces) product B where  $P_a$  and  $P_b$  represent the price ratios for products A and B respectively. ( $\Delta B$  represents the change in product B associated with a change in product A, indicated as  $\Delta A$ .)

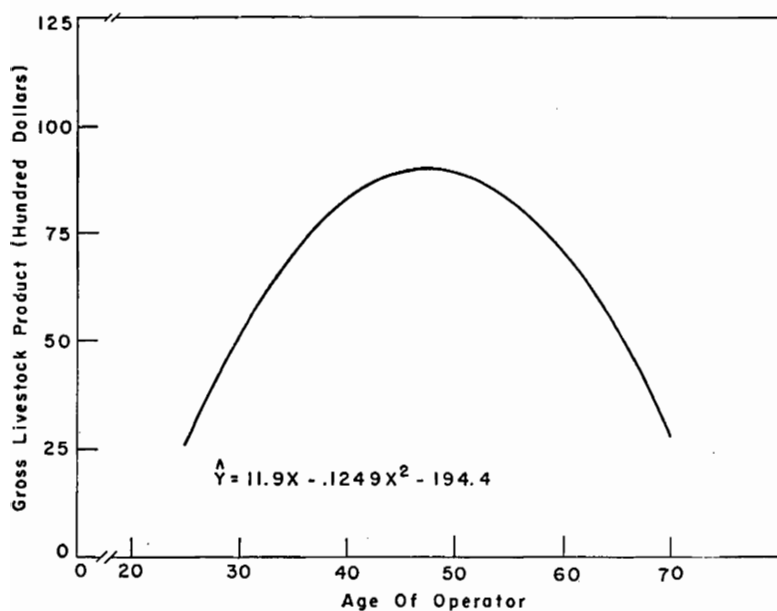


Fig. 11. Relationship between gross livestock product and age of operator.

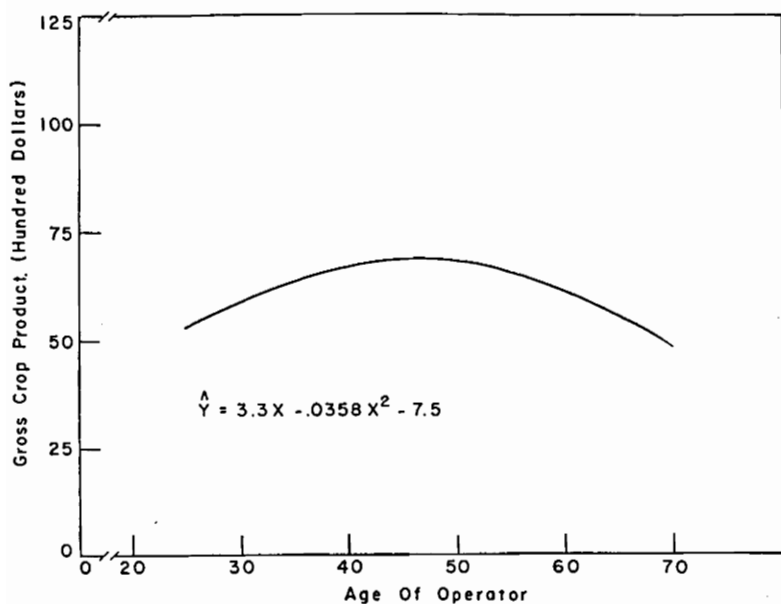


Fig.12. Relationship between gross crop product and age of operator.

of livestock and crop products throughout the life cycle.<sup>20</sup> The cycles are not parallel; livestock production increases most and declines most rapidly over the age span of the farm operator. (See fig. 13.) As the farmer accumulates more capital, greater investment is made in livestock production than in crop production. As a result, the proportion of livestock in the total farm output increases until the farmer is about 48 years old, then decreases. The proportion of crop products relative to livestock is roughly the same for very young operators and for very old operators.

The capital accumulation pattern discussed earlier can be used partly to explain the cycles in crop and livestock production and the rise and decline in the ratio of livestock to crop production. However, there also are other hypotheses to be examined in further studies: The limited capital of

the beginning operator and his aversion to the risks involved in borrowing the quantity of capital required for intensive livestock production brings about the emphasis on crop production in the early stages of the cycle. Returns in crop production are high and the capital turnover is rapid. The young operator with limited capital to invest tends to look upon this pattern of production as a "safer bet" than investments in types of livestock with a slow turnover or with large risks. Also, beginning farmers are found mainly on rented farms where the period of tenure is often too short for livestock farming or where the facilities for livestock are not available. Similarly, the older operator, from the standpoint of his own economic planning, is rational in his selection of enterprise combinations emphasizing crops. The older operator is perhaps concerned with the uncertainty of the market, as are young operators, and uncertainty of life itself. Because the farm investment ordinarily provides his retirement income and since the period of retirement cannot be predicted, the older operator tends to restrict investment in enterprises with a slow turnover. Rather than maintain

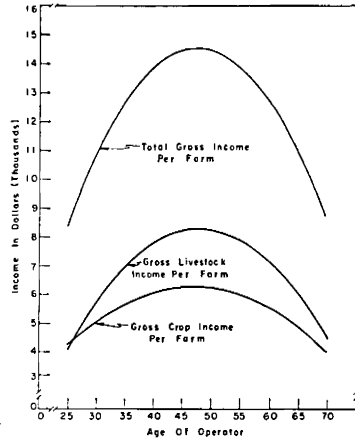


Fig. 13. Gross income per farm and livestock and crop income for different operator ages.

<sup>20</sup> The F values for departure from linear regression were 5.56 for crops and 41.30 for livestock. The former is significant at the 5 percent and the latter is significant at the 1 percent level of probability.



or expand livestock through borrowed funds as his capital base expands, he attempts to pay off his debts and build up a full equity in his real estate assets. Farmers emphasize this form of investment for security reasons. As many older operators point out, they could have made large investments in feeder cattle or other livestock enterprises and gained some of the "postwar windfalls." However, had these ventures proved unsuccessful, their security in ownership of productive assets would have been endangered. The loss of, or reduction in, equity built up for retirement and security may not be recovered in the limited time span ahead of an older operator. In addition, crop production fits into the values or preferences of the older operator better because more leisure time is available in the winter months, and mechanized crop production requires less physical exertion than the care of certain types of livestock. Finally, many of the older operators do not own the resources required for investments in livestock beyond their year-to-year subsistence needs.

Gross income from livestock, crops and the total for the two followed the same pattern as that for the productive assets (fig. 7).<sup>21</sup> However, significant differences in income can be noted in the sources of income as the quantity of capital invested changes. Livestock income increases faster and declines faster than crop income does as the age of the operator increases and as capital investment increases and decreases. Size of capital investment is an important factor in the farmer's choice of livestock and crop combinations. Considerably more capital is required for building up a livestock enterprise than for increasing the crop enterprises. Thus, crop enterprises are substituted for livestock enterprises in the beginning of the cycle, and the substitution is reversed as the farmer accumulates capital.

#### CONSERVATION OF SOIL RESOURCES

The production patterns pointed out above have impacts on production efficiency over time, in addition to the impacts at any one point in time. Soil conservation is an important problem in production and resource use over time. Cropping patterns and farming systems found on farms of both young

<sup>21</sup> The following were the regression equations:

$$Y_7 = 395.358X - 4.203X^2 - 3011.27$$

$$Y_8 = 755.20 X - 7.87 X^2 - 9807.43$$

$$Y_9 = 1143.07 X - 12.00 X^2 - 12640.82$$

Where  $Y_7$  = Gross income of crop,  $Y_8$  = gross livestock income,  $Y_9$  = total gross income and  $X$  = age of operator as before. The first of the above equations has  $X$  and  $X^2$  coefficients significant at the 5 percent level. The coefficients of the  $X$  and  $X^2$  terms on the other two equations were significant at the 1 percent level. Ninety-five percent confidence limits on the coefficients were:

$$Y_7 = X: .8228 \text{ to } 7.0843; X^2: -.0751 \text{ to } -.00898$$

$$Y_8 = X: 3.2091 \text{ to } 11.8948; X^2: -.1245 \text{ to } -.0329$$

$$Y_9 = X: 4.6991 \text{ to } 18.1623; X^2: -.1910 \text{ to } -.0489$$

and old operators tend to be those with the smallest degree of conservation. The relative emphasis on crops rather than on livestock results in exploitive cropping systems; row crops rather than forages become the center of farm organization on these units; returns on forages relative to cash crops are low when livestock is not present for the processing of feeds and the forage and grain crops must be marketed. Although exploitive farming systems are consistent with the tenure arrangement, the capital position, the physical capabilities and the needs of many young or old operators for family income, they do not always result in a level of conservation consistent with the welfare of consumers over time.

#### LABOR-LAND RATIO AND ECONOMIC EFFICIENCY

Changes in the value of productivity of resources throughout the life cycle of the farm operator can be explained partly by the combination of resources employed. As fig. 14 indicates, the number of acres operated per unit of labor increases at the outset but begins to decline about mid-point in the range of ages studied.<sup>22</sup> The explanation for this change in combination of land and labor is found mainly in

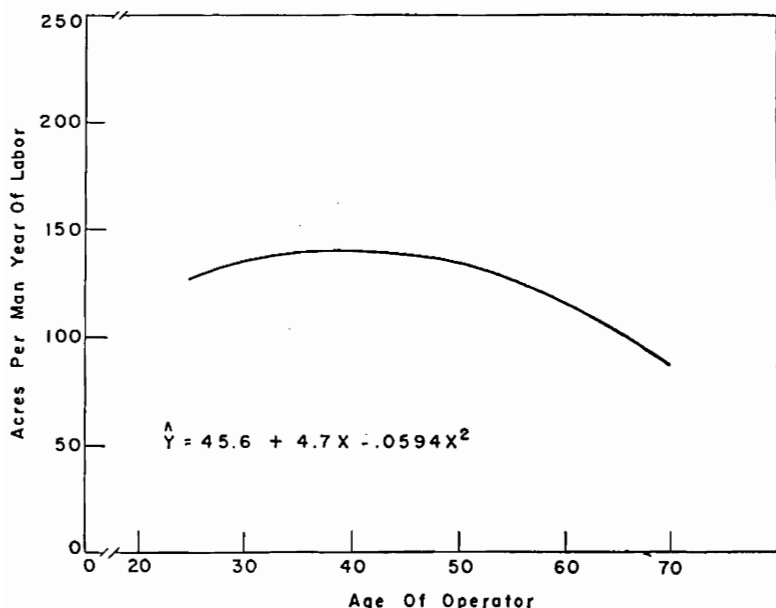


Fig. 14. Relationship between acres operated per man year and age of operator.

<sup>22</sup> The F value for departure from linear regression was 4.40, a value significant at the 5 percent level of probability.

capital accumulation pattern, family labor changes and farm retirement motives. During the beginning stages, the farm operator has his own labor available and tends to substitute it for capital, the resource most severely limited. As he accumulates capital and extends his credit base, he is able to operate a larger acreage without a proportionate increase in the amount of labor employed. The 12 months of labor on the beginning farm is often in excess of that needed for combining with the other productive assets of the farm. The transition made from tenant-operation to owner-operation typically results in a reduction in the number of acres operated; owner-operated farms are smaller on the average than rented farms in all sections of Iowa. Although land inputs are contracted as the shift in tenure is made, labor inputs do not contract accordingly. The fixed labor of the operator is available and other family members often are available for farm work before and after the shift in tenure. The decline in the quantity of real estate capital relative to the amount of labor resources should itself result in a decline in the average and marginal productivity of capital. These considerations are more important on the farm of the older operator. The more intensive use of capital relative to labor causes a decline in capital productivity, and the less strenuous enterprises such as the beef cows found on many semi-retirement farms give a relatively low capital turnover.

#### LABOR-CAPITAL RATIO AND ECONOMIC EFFICIENCY

The proportion of total capital (land, buildings, livestock, machinery, feeds, seeds, etc.) per unit of labor follows a cyclical pattern similar to the land operated per unit of labor as indicated in fig. 15.<sup>23</sup> The change in ratio of total capital to the amount of labor employed can be explained in the same way as the change in land-labor ratio. The cycle in capital available to the operator causes the productivity of resources to go through the phases outlined previously.

Changes in the quantity of capital employed per farm, with corresponding changes in the quantity of other resource inputs, would allow constant productivity of capital resources only if agricultural production took place under conditions of constant returns to scale.<sup>24</sup> Resource combinations in the area studied change the cycle of the farm family

<sup>23</sup> The value of  $F$  for departure from linear regression is 4.28, a value significant at the 5 percent level of probability.

<sup>24</sup> Constant returns to scale occur when the output changes by the same percentage as the proportional changes in the productive resources employed. For example, if all productive resources of a farm are doubled and the output also doubles, constant returns to scale in this range occurs.

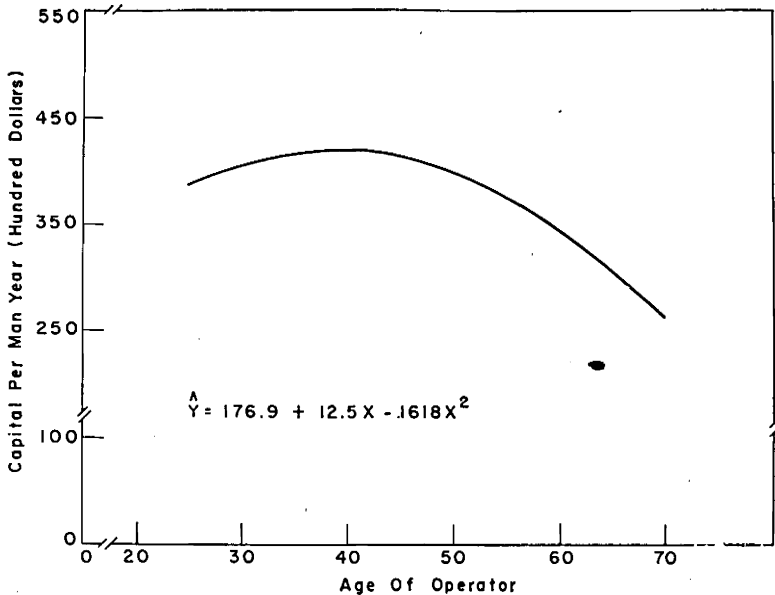


Fig. 15. Relationship between capital per man year and age of operator.

to allow resource productivity to increase with increase in capital investment in the early part of the cycle then decrease as less efficient combinations of resources are chosen for the larger sizes of capital investment. If constant resource productivity did exist, capital limitations and the farm life cycle would not lead to inefficiencies in production. The total product per unit of given resources, aside from differentials in management and family values would be the same from a group of farms irrespective of the quantities of capital employed by the individual units. However, with conditions of increasing and decreasing returns to capital investment existing in agricultural production, the life cycle of the farm and the corresponding variations in the amount of resources employed must result in differences in resource returns for individual farms at different points in the cycle and for a single farm as it progresses over the cycle.

The increase in capital investment in the first part of the cycle permits farmers to select more efficient combinations of factors and products. A wider range of choice in these combinations occurs with increased capital investment. However, the technology available to farmers imposes a limit on the selection of more efficient asset combinations with increased capital investment. There is some size of capital investment that approximates an optimum in terms

of the capability of the farmer and the production possibilities available to him. There are economies to larger capital investments insofar as the larger investments facilitate a more efficient combination of productive assets. When no further economies can be attained in this manner, one would expect the accumulation in productive assets to discontinue. Probably with the current technologies and machines employed by farmers in North Central Iowa, farmers in the middle of the family cycle approach this stage in capital investment.

#### COMBINATION OF PRODUCTIVE ASSETS

Further analysis of the general pattern of asset combination changes with changes in operator age was facilitated by the changing of the regression equations for each category of capital to percentages (as before for land). These percentages indicated lower proportions of machinery and livestock relative to land managed in the beginning and latter periods of the cycle compared with the proportions of these factors in the middle of the cycle (fig. 16). No attempt was made to estimate with data which stage in the cycle corresponded to the best combination of assets. However, it can be deduced that the first and last stages did not correspond to the best combinations attained. The beginning farm operators most usually were tenants faced with the problem of accumulating livestock and machinery. This accumulation takes time. There is a limit on the amount of credit obtained for purchasing capital items. The limit on the use of credit comes about both from the small credit base and from the desire of the farmers not to be too deep in debt at any one time, and as mentioned previously, labor is substituted for capital to a greater extent in the beginning stage of farming.

The farm operator in the latter part of the cycle performs less farming activity. Land is reduced less than machinery and livestock as the contraction in the size of the business occurs. The decline in machinery occurs by not replacing the machines at the depreciation rate and in not making new purchases. Livestock are reduced through marketings. Land is contracted to the size of the unit desired for retirement and/or transfer to the next generation. The decline in farming activity cannot be identified with the same degree of economic efficiency as attained by farmers in the middle of the cycle. Thus, it is deduced that farmers near the middle of the cycle, in general, are more efficient than the younger or older farmers.

Management and labor are a part of the factor combi-

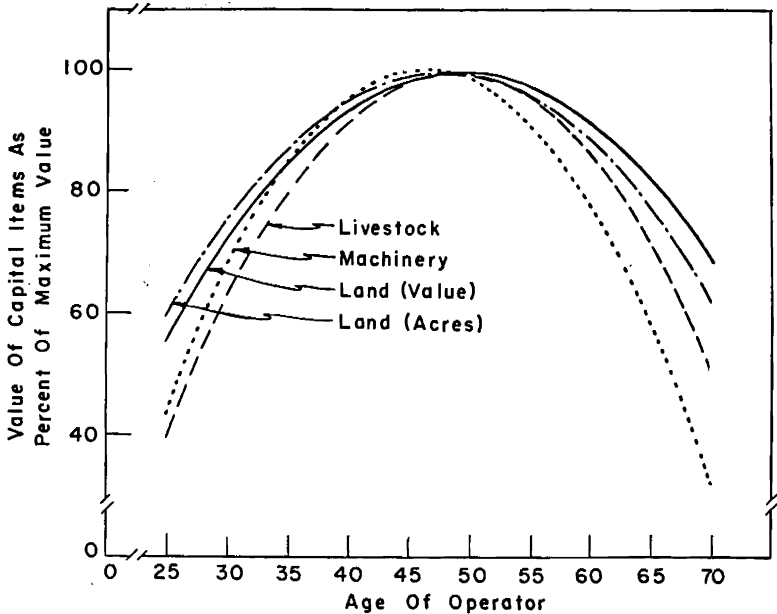


Fig. 16. Average percent of maximum value and acres of land and value of machinery and livestock per farm by age of operator.

nation, but management is excluded in the measurements of fig. 15. We would not expect managerial ability to take the same pattern as the quantity of productive assets per farm over the cycle. While not tested in this study, a reasonable hypothesis is that managerial ability of an individual increases throughout the cycle or until near the end of the farming career; management then would be under-used in the latter stage of the family cycle. This under-utilization probably might arise from family values leading to an increase in non-farming activities and a decrease in interest in maximizing monetary gains in farming.

Data on labor inputs per year per farm were presented earlier (fig. 11). These inputs provide only a rough measure of the pattern of the comparable inputs of labor over the life cycle. The pattern of labor inputs is consistent with an earlier inference on the substitution of labor for capital in the accumulation period. But it is difficult to explain why the farmers in the latter stage of the cycle apparently are also substituting labor for capital. A possible explanation is that the accomplishment in farm work per day decreases rapidly on the average for farmers as their age increases beyond 50 years.

## UNCERTAINTY AND ECONOMIC EFFICIENCY

Uncertainty may be identified with knowledge limitations. The greater a farmer's knowledge, the greater his ability to make wise choices of asset and product combinations. With perfect knowledge (no uncertainty), we would expect farmers to attain, rather quickly, the size of investment near optimum for efficient production. The presence of uncertainty limits the rate of capital accumulation; the less the uncertainty, the faster the accumulation. For example, no risk would be involved in borrowed funds under perfect knowledge. Credit would be used to the limit of the productivity of capital instead of restricted because of risk to the borrower and the lender.

Whether uncertainty restricts the ultimate size of investment during the cycle is not clear. To the extent that a slow rate of accumulation limits the ultimate amount accumulated, uncertainty does limit the size of capital investment by an individual farmer. On the other hand, imperfect knowledge may cause farmers to accumulate a margin over expected requirements for security, thus having the opposite effect on farm size.<sup>25</sup> The farmer could accumulate enough in assets to add another farm to his business operations if no advantages were present for enlarging operations on the same farm. However, the occurrence of decumulation in the latter half of the cycle indicates the presence of individual and family values which are important determinants of the scale of operations in agriculture.

## CAPITAL ASSETS AND LIABILITIES

Table 2 below provides the basis for many farmer decisions over the age-life cycle. All farmers in the sample are included in these data. The figures suggest why farmers with different amounts of capital make different decisions in respect to production and resource use. Farmers at the beginning of the age span have lowest equities and consequently the risks involved in investing in long-period resources and enterprises (plus the need for a quick-turnover of capital) keeps them from investing in livestock. The majority of beginning operators borrowed funds for production capital; very few reported real estate indebtedness since the majority rented land. The percent of farmers with real estate indebtedness increases up through age Group III. While more than one-fourth of age Group IVa reported real estate

<sup>25</sup> The farmers in the sample were asked whether they expected to accumulate a margin to take care of unforeseen contingencies. About two-thirds answered in the affirmative, with amounts varying from 5 to 75 percent extra.

TABLE 2. COMPARISON OF AVERAGE CAPITAL AND LIABILITIES OF 135 OPERATORS IN IOWA CASH GRAIN AREA OF FARMING

	Age group				
	I	II	III	IV	IV(a)
Percent of operators reporting productive and miscellaneous indebtedness	74	45	28	11	7
Average amount of productive and miscellaneous indebtedness	\$ 3,435	\$ 3,974	\$ 2,311	\$ 1,512	\$ 500
Percent of operators reporting real estate indebtedness	7.89	26.32	34.38	25.93	28.57
Average amount of real estate indebtedness*	\$14,500	\$19,600	\$12,409	\$ 6,048	\$ 4,509
Average percent of equity	69	86	94	95	94
Percent of operators reporting non-farm capital	20	36	53	61	56
Average amount of non-farm capital*	\$ 1,206	\$ 6,457	\$13,006	\$ 8,879	\$ 8,300

\* Average for farmers reporting indebtedness or non-farm capital.

indebtedness, the average mortgage, for those with real estate indebtedness, was less than for any other group. The amount of real estate indebtedness was greatest for Group II; it is greatest in this phase of the cycle because the farmer typically purchases his unit at this time and then begins to repay the loan and build up his equity as a basis for retirement. While real estate indebtedness is greater in Stage II than in Stage I, farmers in Stage I have a smaller equity in respect to total assets. While capital has high productivity when it is used in the quantities indicated for Group II (see earlier sections), operators in Group I hesitate or refuse to use more capital because of their low equities and the increased risk which attends use of more borrowed funds. However, because of the age cycle, the farmer does not press his borrowing to the limits of equity as he accumulates capital and broadens his credit base. Instead, he builds up equity and increases investment in non-farm assets to secure his income during retirement.

#### COMPARISON OF OWNER-TENANCY CHARACTERISTICS

Owner-tenancy characteristics of the operators in the sample are presented in table 3. It was interesting to note that the average number of years the operators had operated on their own in each age group differed by approximately 10 years. The low percentage of operators who started with parents in the first age group is probably a result of eliminating from the sample those who were actually operating



TABLE 3. COMPARISON OF OWNER-TENANCY CHARACTERISTICS OF 144 OPERATORS IN THE CASH GRAIN AREA OF IOWA

	Age group			
	I	II	III	IV
Average no. years operated on own	5	15	27	34
	(percent)	(percent)	(percent)	(percent)
Owned and lost a farm	—	—	6.9	17.9
Operators started with parents	25.0	35.9	29.4	19.4
Owners	15.0	41.0	79.4	71.0
Operators renting land	90.0	69.2	41.2	38.7
Tenants only	85.0	59.0	20.6	29.0
Part owners	5.0	10.2	20.6	9.7

with a parent at the time of the survey. Ownership increased with age and tenancy decreased. It can be noted, however, that many owners also were renters. The higher percentage of part-owners occurred in age Group III (50-59 years of age). There was not a significant difference in the combination of production assets between owners and tenants of the same age.

#### ACCUMULATION OF CONSUMPTION ASSETS

Unlike the pattern of accumulation of productive assets, accumulation of refrigerators, ranges and other household items occurs in the early part of the life of the farm family.<sup>26</sup> (There are other consumption items not obtained in the sample.) Families owned about \$2,200 worth of these items on the average, regardless of age of the operator. The competition between the household and farm business for use of capital is particularly strong in the beginning of the family cycle, prior to the accumulation of a margin large enough for the family to easily finance its needs in both areas. Perhaps the extensive use of production credit in the early part of the family cycle is partly brought on by the lack of sufficient capital to purchase the "necessities" for both the household and the farm business.

#### FARMER ATTITUDES AFFECTING USE OF RESOURCES IN PRODUCTION AND CONSUMPTION

The questions in the field schedule relating to attitude and values were designed to provide a guide to explaining the cyclical patterns in production and consumption. Part of

<sup>26</sup> The regression equation of value of household items (Y) on operator age (X) was:

$$Y_{10} = .4223X - .00339X^2 - 10.2843$$

The X and X<sup>2</sup> coefficients did not differ significantly from zero.

the information obtained on attitudes has been cited already. The proportion of the study devoted to farmer attitudes and values was small. Thus, the information obtained can serve only as a partial explanation of the role of values in farm production. More refined studies of farm family values could be based upon the information obtained in this study.

#### OCCUPATIONAL PREFERENCES

More than 90 percent of the farmers interviewed indicated farming to be the most satisfying occupation in life. Half of the farmers had considered other occupations prior to the selection of farming as a life pursuit. About one-fourth of the farmers had no training to qualify them for other occupations, and three-fourths selected farming as a first choice regardless of other employment opportunities.

To obtain some general notion on just how strong these preferences were, the following question was asked: By what percent (as compared with 1949) would income have to be higher in the "next best" occupation before you would be willing to transfer? About one-third of the farmers interviewed indicated that no amount would be large enough to induce them to change to another occupation. Replies from others ranged from zero to 100 percent increase in income, with an average of 47 percent increase.<sup>27</sup> If this increase is converted to dollars, we can see that not many non-farm occupations, requiring roughly the same skills, pay the required amount in wages or salaries. For example, consider a farmer at age 30 with a net annual income of \$4,000.<sup>28</sup> A requirement of 47 percent would figure out to be \$5,880 annual income needed in another occupation. The trades and industry offer less than this figure to employees with skills comparable to the 30-year-old farmer. It is possible that individual farmers overestimated the amount needed in the next best alternative occupation. But these figures do indicate a very strong preference for the farming occupation.

#### GOALS IN FARMING AND MEANS OF ATTAINMENT

The majority of the farmers in the sample gave "security" or "retirement" as primary goals in farming. Other goals mentioned were attainment of "independence," "owner-

<sup>27</sup> The replies given when a percent was named were independent of age of the operator. However, the frequency of the number indicating no amount would move them out of agriculture increased significantly from the first to the last stage of the cycle. These, in percentages of total in each stage were: I—16 percent, II—28 percent, III—45 percent, IV—60 percent. From these data, one may infer that it is easier to draw young farmers out of agriculture, which is about as one would expect.

<sup>28</sup> This \$4,000 is an estimate of the average monetary income of the farmers in Stage I of the cycle. This probably is an underestimate of the real income because farm prerequisites were not included.

ship," "home for family," etc. Perhaps the major component of farm people's goals is security. Security is a prerequisite to the other motives enumerated.

Family security goals can be attained by accumulation of capital from the farm business, by using annuity plans or other non-farm investments from surplus capital accumulated in farming or by a combination of the two. About three-fourths (76 percent) of the farmers expected to retire on accumulated property and earnings from this property rather than from outside investments. Others expressed a retirement plan involving investment of savings, or had no plans to relinquish active management and operation of the farm.

Farmers were questioned on various annuity plans for retirement. The responses to these questions indicated that annuities receive little consideration by farm people. Further evidence of lack of interest in annuity plans was indicated by the small amount of life insurance carried by the families. More than half of the families (60 percent) had an investment in life insurance, but the average amount per family was less than \$5,000, or about 10 percent of the average amount indicated as desirable for a retirement fund. Life insurance serves the purpose of providing an element of safety while farm capital is being accumulated to provide the security and standard of living desired. Farmers have two methods of providing funds for retirement. They can build up a "stock" of funds and live from this stock during the period of retirement; or they can build up an investment and live from the *earnings* (a flow) of the investment. For example, a farmer expecting to live over a 10-year retirement period and use the *stock* system would need to accumulate \$20,000 if \$2,000 were required per year for living purposes. A farmer expected to use the fund system alone and requiring the same annual income during retirement, would need to accumulate \$50,000 if the annual earnings rate were 4 percent; 4 percent per annum of \$50,000 is \$2,000. Thus the *fund* system would require 2.5 times as much accumulated capital as the *stock* system. Which system do farmers employ and what are its ramifications in the farm capital structure?

Although the majority of the farmers in the sample viewed accumulation of farm property as the primary means for attaining the security and living standards desired, liquid holdings in the form of non-farm property are important. The schedule contained questions aimed at ascertaining the farmer's attitudes toward accumulation in the form of non-farm compared with farm property. Specifically, the questions asked were: "What amount of capital do you think you

should accumulate if you were to live on *accumulation* property during retirement? What amount of capital do you think you should accumulate if you expect to live (only) on *earnings* from the accumulation?" A summary of the replies to these questions and information on expected retirement period is presented in table 4. Farmers did make a difference in the two retirement plans. They believe farm property offers greater security than non-farm property of comparable money value.

TABLE 4. AVERAGE INDIVIDUAL FARMER ESTIMATES OF CAPITAL REQUIREMENTS FOR RETIREMENT AND LENGTH OF RETIREMENT PERIOD

Operator stage	Amt. for ret. on farm property	Amt. for ret. on earnings from cap.	Expected age of retirement	Life expectancy	Estimated length ret. period
I	\$32,300	\$40,700	60	72	12
II	37,100	54,900	61	71	10
III	27,500	55,200	64	76	12
IV	27,200	54,800	66	79	13
Weighted average	\$31,500	\$50,400*	63.5	74.2	11.7

\* Difference between estimates needed for retirement by the two plans significant at the 1 percent level. Ninety-five percent confidence limits on the mean difference of \$18,900 was \$13,700 to \$24,100.

One of the major reasons for the particular estimates given for retirement requirements in the form of farm property was the farmers' notion of the capital requirements for farm units desired. For example, the amount indicated as needed for retirement on farm property correlated closely with the amount of farm capital currently managed.<sup>29</sup> This finding is consistent with the findings on occupational preferences and goals in farming.

#### UNCERTAINTY, RETIREMENT SYSTEMS ON CAPITAL ACCUMULATION

The strong tendency for farmers to use the *flow* or earnings system of retirement relates closely to uncertainty, although the values placed on capital accumulation per se, the passing-along of an inheritance to children and other considerations are important. The farm operator is concerned with two facets of uncertainty as he views retirement in a future period. One is uncertainty of life itself and the other is uncertainty of the market. Selection of the *fund* rather than the *flow* system is an uncertainty precaution in either case. If a farm couple accumulates \$20,000 (see discussion

<sup>29</sup> This correlation coefficient was .58.

above) for a fund-type of retirement and their life extends over 15 years, they will have completely consumed their retirement stock at the end of 10 years and will have to turn elsewhere in the remaining five years. Similarly, if the stock of capital is invested and depression comes about, its value may drop sharply and allow only meager values or returns for retirement income. The flow system serves as an uncertainty precaution since the earnings on \$50,000 (the example above) amounting to \$2,000 would extend equally beyond a 10-year period, and if depression comes about, the greater fund itself may be consumed. While market uncertainty itself acts as a deterrent to the use of capital in the beginning (and other) stages of farm operation, uncertainty of the market and life itself, may cause a heavy emphasis on capital accumulation for the retirement stage of the life cycle. Perhaps one positive aspect of uncertainty is this premium which is placed on capital accumulation; economic progress and the gains to all of society over time may spring partly from this phenomenon.

#### ATTITUDES TOWARD INDEBTEDNESS

A farmer's attitude toward indebtedness reflects his values for ownership (equity) in a business and his estimate of the degree of uncertainty connected with being in debt. Due to the need for accumulation in the early part of the family cycle, we could expect an attitude against indebtedness to be less strong in this period, with greater degree of "conservatism" as the goals of the farm family come nearer being realized.

Our data were fragmentary on this point, but do indicate support to the above hypothesis. Farmers were asked whether they thought it advisable to borrow for farm production at operator ages 25, 35, 45 and 55. A summary of the replies to this question is presented in table 5. In general, the farmers in the sample thought it less desirable to be in debt after operator age 35. A more significant change in attitude toward the use of credit occurred as the age of operator increased. Farmers already in Stage III of the cycle, with a median age of 55, indicated a greater desirability of borrowing for production purposes at operator age 55 than did farmers in other stages of the life cycle.

Although many operators would advise borrowing for use in production, they still may have preferences for not being in debt. To check this, the farmers were asked whether they thought it undesirable to be in debt. A summary of the affirmative answers to this question, grouped by stages of the

TABLE 5. PERCENT OF FARMERS IN SAMPLE, BY STAGES IN FAMILY CYCLE, INDICATING ADVISABILITY OF OBTAINING CREDIT AT DIFFERENT OPERATOR AGES

Operator stage	Percent advising the use of credit at operator ages:			
	25	35	45	55
I	97.5	97.5	71.8	47.8
II	100.0	100.0	76.9	35.9
III	100.0	97.1	83.9	61.8
IV	93.5	93.5	85.2	48.3

family cycle, was: I—56.4 percent; II—53.8 percent; III—51.5 percent; IV—75.9 percent. Since these figures were much lower than the percentages in the first three columns of table 5 it can be inferred that many farmers advise obtaining credit for farm production even though they do not think it wise to be in debt. Farmers in the last stage of the cycle had the stronger values against indebtedness.

The percentage of the farmers actually with some amount of indebtedness were: I—78.9 percent; II—58.9 percent; III—46.9 percent; IV—33.3 percent. These data correspond closely to the expressed opinions about indebtedness. The presence of these attitudes toward indebtedness influence the rate of farm business expansion. Slower rates of expansion can be expected for farmers with stronger preferences against indebtedness.

#### ATTITUDES TOWARD THE USE OF ADDITIONAL CAPITAL

An attempt was made to find out how farmers would allocate additional capital if it were available to them, i.e. capital in addition to that currently owned. Hypothetical cases were constructed for this purpose, such as winnings in a lottery or an unexpected prize of \$1,000 and \$10,000. The opinions are subjective expressions and do not necessarily represent exactly how the farmers would use additional capital; but they do represent an approximation of farmer attitude on how added capital would be spent. These data are summarized in table 6. The amounts of capital (\$1,000 and \$10,000) had an insignificant effect on the allocation plans stated by farmers. These data suggest that a significant increase in the proportion of capital would be allocated to consumption as age of the operator increased.

#### ALLOCATION OF INCOME

While the farmers possessed no records indicating how income from the farm currently was allocated between uses

TABLE 6. FARMER ATTITUDE TOWARD USE OF ADDITIONAL CAPITAL BY STAGE OF FAMILY CYCLE

Operator stage	Allocation of \$1,000		Allocation of \$10,000	
	Investment* (percent)	Consumption (percent)	Investment* (percent)	Consumption (percent)
I	96.3	3.7	92.0	8.0
II	83.4	16.6	90.0	10.0
III	65.0	35.0	69.4	30.6
IV	82.7	17.3	81.4	18.6

\* Investment includes savings and farm business purchases.

in production and uses in consumption, they estimated about 50 percent to each, with little differences due to age of the operator. Farmers were questioned on how they thought farm income should be allocated between production and consumption. The arbitrary operator ages of 25, 35, 45, 55 and 65 were used as a guide for farmers in answering this question. The results are summarized in table 7. The significant feature of the data is the increase in consumption with a corresponding decrease in investment thought desirable near the end of the family cycle. This is consistent with earlier findings that attitude changes as family cycle continues. Since farmers of all ages estimate about the same pattern of allocation, it can be concluded that farm people are aware of the changing pattern of values rather early in the cycle, and this pattern comes close to realization. This fact emphasizes the importance of the family cycle in the activities and plans of farm people.

TABLE 7. FARMER ATTITUDES TOWARD USE OF FARM INCOME AT DIFFERENT OPERATOR AGES, BY STAGES OF THE LIFE CYCLE

Operator stage	Suggested percentages division of income at operator ages:									
	25		35		45		55		65	
	Farm House-bus.	House-hold	Farm House-bus.	House-hold	Farm House-bus.	House-hold	Farm House-bus.	House-hold	Farm House-bus.	House-hold
I	56	44	55	45	52	48	50	50	36	65
II	49	51	47	53	46	54	43	57	34	66
III	56	44	54	44	52	48	45	55	34	66
IV	56	44	56	44	54	46	49	51	37	73
Weighted av.	54.1	45.9	52.1	47.9	50.8	49.2	46.7	53.3	35.2	64.8

#### PREFERENCES IN CAPITAL EQUIPMENT

Ordinarily it is thought that farmers purchase major capital items, such as tractors and corn pickers, to enlarge the business and increase income. On the other hand,

these machinery items are labor-saving if the scale of operations is not expanded. To find out which consideration farmers consider the most important, farmers were asked the following questions: (a) In the past five years, have you made any investments in farm machinery and equipment to ease the work and to make farming more enjoyable rather than to primarily increase income? (b) What specific investments? Two-thirds of all farmers answered the first question in the affirmative, and some of the specific items mentioned, in the order of frequency were: corn pickers, tractors, combines, loaders, elevators, milking machines, hay balers, field choppers, cultivators, water systems, etc. But these are the major capital items other than land and livestock on Iowa farms.

#### ENTERPRISE PREFERENCES

About one-fourth of the farmers in the sample had preferences for particular livestock enterprises and maintained these enterprises while suggesting that other livestock systems would be more profitable. Some of these preferences were: horses, sheep, purebred cattle, specialized dairy and specialized poultry. Generally, farmers suggested hogs and feeder cattle to be the alternative and more profitable enterprises. The predominance of hog and feeder cattle systems with supplementary poultry and dairy enterprises in the area is, in general, the choice where money income is the major goal of farming.

#### IMPLICATIONS OF FINDINGS AND ALTERNATIVES FOR IMPROVING EFFICIENCY

With high productivity of capital on the farms of beginning operators and a lower return for capital on farms of established and older operators, it would appear that farm resources could be rearranged to allow a greater product from given resources or to allow the same output with a smaller cost outlay. Several alternatives are open in bringing these adjustments about. Some are acceptable to farm people while others are not. A scheme is needed to offset the cycle wherein the farm business grows and declines in productivity with the farm family. Alternatives to help to eliminate the cycle are: (1) father-son or other farm business arrangements to allow the life cycle of two generations to overlap; (2) credit machinery to provide low-equity capital to beginning farmers; (3) corporate organization of farms to prevent the business from "dying with the household;" (4) reduction of price and other uncertainties of the market to increase the extension of credit to farmers; (5) a form of



social security in agriculture and (6) cooperative use of farm resources. These and other similar alternatives need to be examined in other studies with particular reference to their effect on the farm cycle in its relation to productivity.